Exhibit E

WRITTEN RE-EVALUATION OF THE 2022 FINAL PROGRAMMATIC ENVIRONMENTAL ASSESSMENT FOR THE SPACEX STARSHIP/SUPER HEAVY LAUNCH VEHICLE PROGRAM AT THE BOCA CHICA LAUNCH SITE IN CAMERON COUNTY, TEXAS

Deluge System Operation, Addition of a Forward Heat Shield Interstage, and Expansion of the Area of Potential Effects for Cultural Resources

Introduction and Background

Introduction

Space Exploration Technologies Corporation (SpaceX) applied to modify its existing vehicle operator license to support Flight 2 of the Starship/Super Heavy launch vehicle at its existing Boca Chica Launch Site in Cameron County, Texas. This written re-evaluation (WR) evaluates whether supplemental environmental analysis is needed to support the Federal Aviation Administration (FAA) Office of Commercial Space Transportation decision to modify SpaceX's vehicle operator license. The affected environment and environmental impacts of Starship/Super Heavy operations at the Boca Chica Launch Site were analyzed in the 2022 *Final Programmatic Environmental Assessment for the SpaceX Starship/Super Heavy Launch Vehicle Program at the SpaceX Boca Chica Launch Site in Cameron County, Texas* (2022 PEA; FAA 2022). The FAA issued a Mitigated Finding of No Significant Impact (FONSI)/Record of Decision (ROD) based on the 2022 PEA on June 13, 2022. This WR provides the determination of whether the contents, analyses, and conditions of approval in the PEA remain current and substantially valid.

Modifying a vehicle operator license is a major federal action subject to the requirements of the National Environmental Policy Act of 1969 (NEPA), 42 U.S.C. § 4321 et seq. As such, the FAA must assess the potential environmental impacts of modifying SpaceX's vehicle operator license for Starship/Super Heavy operations at the Boca Chica Launch Site. FAA Order 1050.1F, *Environmental Impacts: Policies and Procedures* provides that the FAA may prepare a WR to determine whether the contents of a previously prepared environmental document remain substantially valid or whether significant changes to a previously analyzed proposed action require the preparation of a supplemental Environmental Assessment or Environmental Impact Statement (EIS).

In accordance with Paragraph 9-2.c of FAA Order 1050.1F, the preparation of a new or supplemental EA or EIS is not necessary when the following can be documented:

1. The proposed action conforms to plans or projects for which a prior EA and FONSI have been issued or a prior EIS has been filed and there are no substantial changes in the action that are relevant to environmental concerns;

2. Data and analyses contained in the previous EA and FONSI or EIS are still substantially valid and there are no significant new circumstances or information relevant to environmental concerns and bearing on the proposed action or its impacts; and
3. Pertinent conditions and requirements of the prior approval have been, or will be, met in the current action.

This WR provides documentation for the above three factors including the FAA's conclusion that the contents of the 2022 PEA remain current and substantially valid and that the decision to issue a modification of an existing vehicle operator license for Starship/Super Heavy operations at the Boca Chica Launch Site does not require the preparation of a new or supplemental EA or EIS.

Background

The FAA prepared the 2022 PEA to analyze the potential environmental impacts of constructing launch-related infrastructure and operating the Starship/Super Heavy launch vehicle at the Boca Chica Launch Site. As documented in the FAA's June 13, 2022 FONSI/ROD, and detailed in the PEA, the FAA found that SpaceX's proposed Starship/Super Heavy program, under which SpaceX would conduct up to 5 orbital Starship/Super Heavy launches per year and up to 5 suborbital Starship launches per year from the Boca Chica launch site, and implement identified mitigation measures, would not significantly impact the environment. Following issuance of the 2022 PEA and FONSI/ROD, SpaceX applied to the FAA for a license for a first orbital launch of the Starship/Super Heavy launch vehicle. SpaceX provided the FAA with additional details regarding Starship and Super Heavy planned descents, including potential ocean landing locations. SpaceX also proposed using a detonation suppression system at the vertical launch area, which is designed to spray water towards the engines during ignition events (e.g., launches and other tests) to reduce the likelihood of detonations from free methane mixing in air and autoigniting. The FAA analyzed this new information in an April 2023 WR and determined that the preparation of a supplemental or new NEPA document was not necessary to support SpaceX's Proposed Action previously analyzed in the 2022 PEA, the operation of the Starship/Super Heavy program. The FAA issued the WR on April 14, 2023 (2023 WR; FAA 2023).

Following the issuance of the vehicle operator license, SpaceX conducted a test flight of Starship/Super Heavy on April 20, 2023. The vehicle cleared the pad and the beach, eventually breaking up over the Gulf of Mexico. The concrete launch pad was damaged during the test flight, resulting in dispersal of sand and debris, some of which was deposited outside the 700-acre potential debris study area assessed in the 2022 PEA. The breakup of the launch pad deck allowed the naturally occurring sand underneath to be forced away from the launch pad by the force of the vehicle's thrust.

Following the April 20 launch, SpaceX: (1) reinforced its launch pad foundation with thicker concrete and additional piles; and (2) installed steel plates over the foundation. Both of these improvements are designed to protect against the potential of a pad breakup or a large dust cloud. The steel plates include a water-cooling element (i.e., deluge system) that would be activated to protect the steel plates during an engine ignition event and allow reusability of the steel plates. SpaceX also added a forward heat shield interstage to the Starship/Super Heavy vehicle to provide thermal protection against heat produced by Starship engines during the stage separation event.

This WR evaluates the following:

- The operation of a deluge system,
- The addition of a forward heat shield interstage to the Starship/Super Heavy launch vehicle, and
- The expansion of the area of potential effects (APE) for cultural resources

As explained below, the modifications to SpaceX's proposed launch operations and other new information since the 2022 PEA and April 2023 WR do not require preparation of a new or supplemental EA or EIS. The proposed modifications to launch operations and expansion of the APE are not substantial changes to the Starship/Super Heavy launch operations evaluated in the PEA and FONSI/ROD that are relevant to environmental concerns—the modifications are designed and expected to reduce potential effects. The data and analysis in the PEA and FONSI/ROD remain substantially valid. New information from the first launch and ongoing monitoring does not present any significant new circumstances or information relevant to environmental concerns and bearing on the proposed action or its impacts. Finally, the FAA has and will continue to ensure that SpaceX complies with required mitigation measures and other conditions of the FONSI/ROD.

Water System Components and Operation

Following the April 20, 2023 launch, SpaceX reinforced its launch pad foundation with thicker concrete and additional reinforcement piles. Additionally, SpaceX installed steel plates over the foundation. These features are designed to prevent the potential of a pad breakup and associated debris and dust. The steel plates include a water-cooling element (i.e., deluge system) that would be activated to protect the steel plates during a launch event and allow reusability of the steel plates.

SpaceX proposes to activate the deluge system during engine static fires and vehicle launches. A maximum of approximately 358,000 gallons of potable water would be pushed from ground tanks into the steel plates and released through holes in the plating. The deluge system would apply a large amount of water to rapidly cool and create a barrier between the steel plate and rocket exhaust that will help to absorb sound energy and heat produced by the rocket engines and would allow the steel plate to be reused. It is expected that most of the water would be vaporized by the heat of the rocket engines.

The detonation suppression system[1], previously evaluated in the April 2023 WR, would again be activated during ignition events. The detonation suppression system is independent of the deluge system, and sprays approximately 3,000 gallons of potable water downward from the launch mount ring to prevent detonations from free methane mixing in air and autoigniting during launch operations. The water would be dispersed in the same ways described above for the deluge water, except it is supplied by tubes along the top of the launch mount. Similar to the deluge system, it is expected that of the approximately 3,000 gallons of water from the detonation suppression system, most (if not all) would be vaporized by the heat of the rocket engines.

[1] As noted above, the FAA's April 2023 WR reevaluated the PEA for its validity in light of SpaceX's proposal to develop this detonation suppression system.

Separately, the FireX system (SpaceX's launch pad fire suppression system)[2] would be activated only in the event of a fire on the launch pad. The FireX system is capable of releasing 120,000 gallons of water, however it is anticipated that approximately 20,000 gallons would be used in the event of a fire on the launch pad. The final volume discharged may vary depending on the fire. Most of the water not vaporized by the fire would be collected in the retention areas on the vertical launch area (VLA). The event of a fire and subsequent use of the FireX system would be an unexpected, off-nominal event.

Components of the Deluge System

The deluge system includes the following physical components constructed within the boundary of the VLA. The physical components of the deluge system will not require an expansion of the VLA beyond the area previously considered in the 2022 PEA. The effects of construction activities within the VLA boundary are already considered in the 2022 PEA and prior consultations. The deluge system components are described here for context and to aid in understanding how the system will be operated.

Water Containment: Most of the water applied during operations will be captured by containment structures within the VLA. These containment structures include gutters, a retention basin below the launch pad, one or more retention ponds, and berms. SpaceX has constructed retention areas within the VLA with a total capacity of 276,000 gallons (Figure 1). Additional ponds may be constructed within the VLA with potential capacity of 30,000 gallons. These containment structures also collect stormwater within the VLA. Water captured by the containment structures and meeting water quality standards established by the Texas Commission on Environmental Quality (TCEQ) will be used to refill the water storage tanks to minimize the amount of potable water needed to be trucked in. Water that does not meet TCEQ quality standards will be removed from the containment structures and hauled to an industrial wastewater treatment facility outside the VLA. In accordance with the 2022 PEA, the containment structures are impervious in order to prevent percolation of contaminants into the groundwater. These containment structures are maintained and monitored by SpaceX.

Water Storage: A reliable water source is required to provide the necessary volume, flow, and pressure for the deluge system. Water sources could include potable water from trucks from the nearby town of Brownsville, clean water generating processes at SpaceX facilities, or collected rainwater. The deluge system water will be stored in water storage tanks located within one or more of the tank farm areas of the VLA.

Press Tank: The press tank is a storage tank pressurized with nitrogen gas at 3,000 pounds per square inch. The press tank is connected to the water storage tank(s) to provide the driving force to expel the water when the deluge system is activated.

Pumping System and Piping Network: A system of pumps will move water from the water storage tanks to the piping network of the deluge system. The pumps provide the necessary pressure to ensure effective water distribution. The piping network is a series of interconnected pipes that

[2] The FireX system is a separate system from the detonation suppression system and deluge system and is used in the event of a fire on the launch pad. The PEA addresses SpaceX's planned response in the event of a fire on the launchpad.

distribute water throughout the deluge system. The existing piping network is designed to deliver the required amount of water to the launch pad and rocket.

Control System and Valves: The control system is used to activate and deactivate the deluge system and includes sensors, actuators, and a central control unit to monitor water levels, pressures, and system status. It allows operators to activate or deactivate the deluge system, adjust flow rates, and receive alarms or notifications regarding system performance or anomalies. Control valves are installed within the piping network to regulate the flow of water at various sections of the deluge system. These valves allow for manual or automated control over the distribution of water to different areas as required. Flow meters monitor and measure the amount of water being supplied by the deluge system. This information helps in maintaining the desired flow rates and ensuring adequate water supply.

Deluge System

Several spacecraft launch and testing facilities around the world employ deluge systems to improve operational safety, absorb vibrations, and protect the integrity of the launch pad infrastructure. Notable examples include the Kennedy Space Center in Florida, the Vandenberg Space Force Base in California, the Baikonur Cosmodrome in Kazakhastan, and the Satish Dhawan Space Centre in India.

Consistent with these other sites, SpaceX has proposed to use a deluge system to cool the area around the VLA and absorb vibrations to improve safety and protect infrastructure so that it can be reused. SpaceX installed a steel plate below the launch pad after the April 20, 2023 launch. Without the water-cooling element, the steel plate would melt and would need to be replaced after each launch attempt.

During engine ignition the surface of the pad flame deflector may experience a small amount of ablation. Ablation is the mechanical erosion of steel from the surface of the metal as result of exposure to heat and force and is considered a common consequence of activities on metal launch infrastructure. The ablated steel would be minimal and would quickly recondense near the launch mount when exposed to the deluge water.

The operation of the deluge system would also help minimize the risk of fires igniting in or spreading through adjacent vegetated areas, either within the unconstructed portion of the VLA or outside of the VLA. As detailed below, deluge system water would leave the launch pad and the constructed portion of the VLA which could at least partially mitigate fire within the unconstructed part of the VLA where most of the vegetation adjacent to the VLA occurs by dousing the surrounding area with water (a fire prevention tactic) and creating condensation which could help suppress fire beyond the VLA.

Figure 1 Existing Retention Pond Locations

Operation

The deluge system would be activated during each ignition event on the orbital launch pad, including engine ignition tests and launches. The 2022 PEA contemplates annual operations of up to five orbital launches and five suborbital launches per year. Each launch is associated with an estimated two static fire engine tests. The planned additional orbital launch mount, which is evaluated in the PEA, will also include a deluge system and containment. However, the design of this mount is not yet final. The construction of the additional orbital launch mount will not affect planned operational cadence. No deluge system is planned for the existing suborbital launch mount. Therefore, the deluge system may operate up to 30 times per year.

The deluge system would be activated immediately prior to an engine ignition event, allowing water to flow from the storage tanks, through the piping network, to the spray nozzles at the launch pad. Five seconds prior to ignition, water would begin discharging. Most of this pre-ignition water would be captured by the containment structures. The amount of water applied during activation of the deluge system will differ depending on the type of ignition event. It is estimated that approximately 72,000 gallons of water would be used for each static fire, and approximately 132,000 gallons of water

for each launch event; however, for the purposes of this analysis, it is assumed that 361,000 gallons, the maximum volume of water available in the tanks, could be used, which includes 3,000 gallons of detonation suppression water which is supplied from a different tank.

For the purposes of this assessment, it assumed that the maximum amount of water could be dispersed by a combination of all dispersal methods described below. Based on modeled and collected data from the deluge tests, most of the water prior to engines startup and following engine shutdown would be collected in the retention areas or pushed out and 92% of the of the water would vaporize when engines are on. The exact proportion of the water involved in each mode of dispersal may vary with the specific conditions of each ignition event.

Overland Sheet Flow: Some of the deluge water would disperse over land as sheet flow. Most of the sheet flow will be captured by the water containment structures and confined to the existing developed area of the VLA. It is possible that some sheet flow would either evade or overwhelm the containment structures, and travel into the areas immediately adjacent to the developed area of the VLA. It is expected that most of the sheet flow would not travel beyond the expanded, unconstructed, area of VLA boundary.

Push Out: During an ignition event, some of the water applied by the deluge system could be pushed by the rocket thrust past the containment structures. Some of this water may be pushed beyond the boundary of the existing developed area of the VLA. Similar to the possible extent of overland sheet flow, it is expected that pushed water would infiltrate the areas immediately adjacent to the site. The exact volume of water that may be pushed away and the distance that it will carry is likely to vary with the specific conditions of each ignition event.

Vaporization: The heat from the rocket fire would vaporize most of the water applied by the deluge system and would generate a cloud of steam and aerosolized mist. Based on the amount of water, the heat of the plume is expected to dissipate quickly and the majority of the vapor cloud is expected to take the form of aerosolized mist near the VLA. The vapor cloud would extend over the land and into the air as it is energized by the heat of the rocket plume. The temperature of the vapor cloud would depend on the temperature of the heat plume. With the addition of the water, the distance the heat travels is expected to be less than analyzed in the 2022 PEA. The vapor cloud would disperse quickly. As a conservative estimate, SpaceX expects the maximum extent of the vapor cloud to be no greater than the 0.6-mile radius of the heat plume analyzed in the 2022 PEA (Figure 2). Since the vaporization would occur from the thrust and heat of the vehicle, water vapor is not expected to form beyond the extent of the modeled plume. The fate of the vapor cloud as it cools would be either evaporation or condensation.

Evaporation: Water can be considered evaporated when it transitions from a liquid to a gas and becomes dispersed in the air, contributing to the overall moisture content of the atmosphere. The specific point at which water vapor is considered to have evaporated into the atmosphere is not well-defined, as evaporation is an ongoing process influenced by various factors such as temperature, humidity, and air currents. It is possible that most or all of the vapor cloud would evaporate instead of condensate and remain in the atmosphere instead of falling back to the surrounding area.

Condensation: As the vapor cloud begins to cool, water molecules come together to form liquid droplets. Condensation may create clouds in the air or fog near the ground. Condensed water may

fall as rain or form dew on vegetation and other surfaces. As a conservative estimate, SpaceX expects the extent of the condensation directly attributable to condensation of the vapor cloud to be no greater than the 0.6-mile radius of the heat plume. Based on video from the April test flight, the approximate maximum distance the plume advances before stopping is approximately a 0.2-mile radius. With the addition of the steel plate deflector, this diameter is expected to be reduced due to the additional mass being added to the system. Additionally, temperature data recorded during the April test flight, when extrapolated, shows a predicted temperature of 80°F at an approximately 0.3-mile radius. Due to the variability of winds, humidity, and temperature, a conservative 0.6-mile radius is used as the potential distance the vapor/plume cloud could reach. Beyond that distance, evaporated water from the vapor cloud would be greatly dispersed and mingled with other atmospheric moisture.

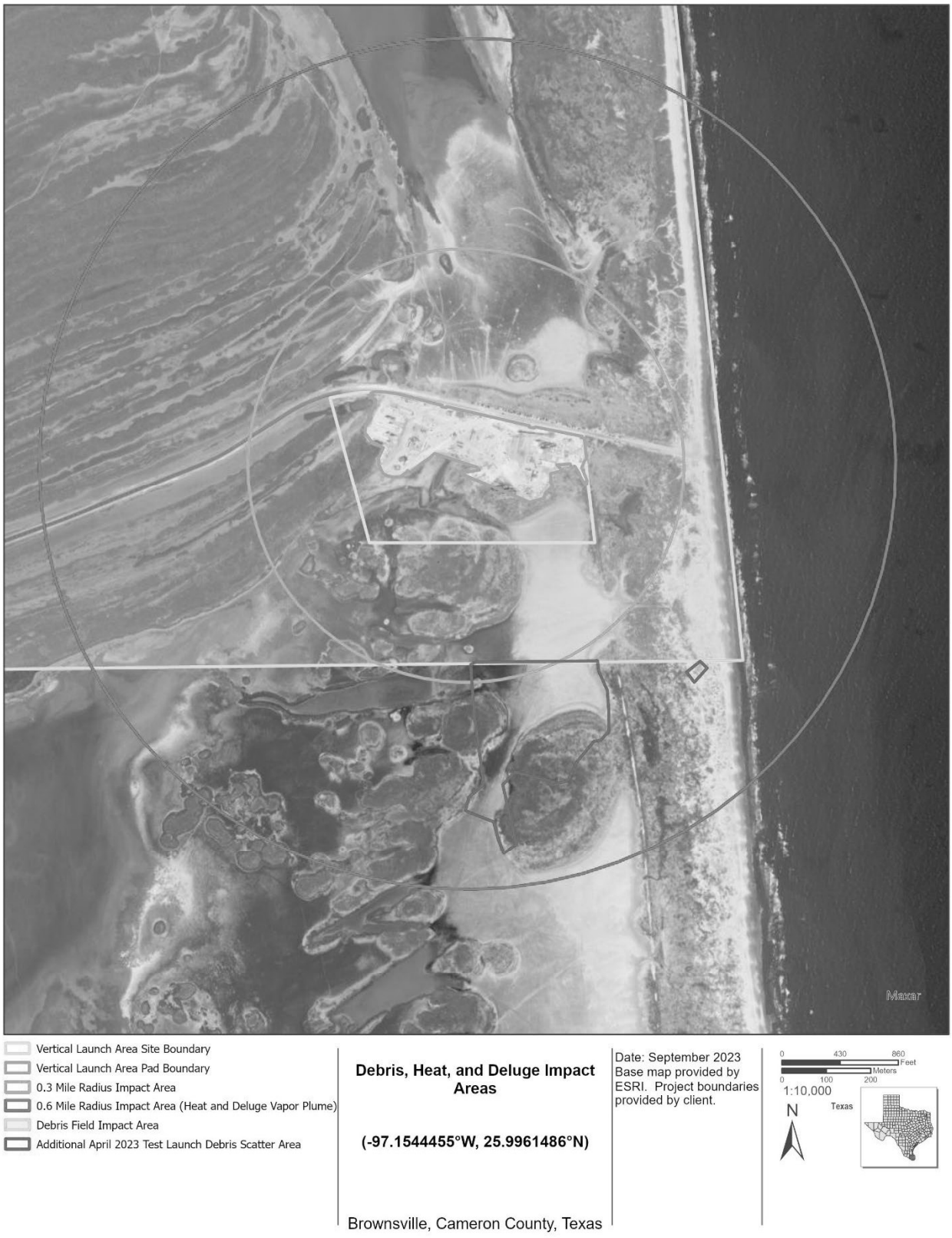

Figure 2 Deluge Impact Area

Ablation: Launch mount structures, flame deflectors, noise suppression systems, framing, and mobile launch platforms are common steel components used across the rocket launch and testing industry. During engine ignition of the Starship/Super Heavy, surfaces of the steel infrastructure can experience ablation. Ablation is the mechanical erosion of steel from the surface of the metal as a result of exposure to heat and force and is a common consequence from launch vehicle plumes on launch infrastructure (NASA 2015). The Starship/Super Heavy engine plume, when in contact with the steel divertor, could ablate up to 190 pounds of steel per launch. Relative to launch systems that use different solid propellant systems with high metal content, like the Space Shuttle and the Space Launch System, the metal from ablation associated with Starship is extremely minimal. No ablation was noted during recent static fire operations.

There has never been any previous analysis or modeling done to quantify and assess metals from ablation of steel launch pad infrastructure. Nonetheless, impacts from metals from the plumes of the propellant of solid rocket boosters (SRBs) used on the Space Shuttle have been analyzed by the National Aeronautics and Space Administration (NASA; NASA 2014) and are a reasonable proxy to determine the significance of minimal steel ablation. SRBs are made up of a solid propellant mixture consisting of ammonium perchlorate, aluminum, and iron oxide that react to produce hot gases at high-speed, creating thrust which results in deposition of metals from the plume of the vehicle. Starship/Super Heavy is powered by Raptor engines which use liquid oxygen and liquid methane as propellants, not SRBs. As such, for Starship/Super Heavy, no metals are present in the propellant nor would be produced from the combustion of these propellants. The ablation from the steel plating for the Starship/Super Heavy is not a consequence of a chemical reaction from the vehicle but rather a localized event occurring when the plume contacts the stainless-steel plate comprised of chromium, nickel, and iron. This ablation results in substantially lower levels of metals than are produced by the full burning of the SRBs.

During launch of the Space Shuttle, the SRBs caused acid and particulate deposition around the launch pad in both the near- and far-fields. This deposition was made up primarily of aluminum oxide and hydrogen chloride, occurring due to atomization of the deluge water by the turbulence of the launch vehicle exhaust. As analyzed in the *Ecological Impacts of the Space Shuttle Program at John F. Kennedy Space Center* (NASA 2015) and *Final Constellation Programmatic Environmental Impact Statement* (NASA 2008), near-field impacts (launch pad to approximately 1 mile) were generally within the immediate vicinity of the launch complex (NASA 2015)**Error! Bookmark not defined.**. Far-field deposition was dependent on atmospheric and meteorological conditions and generally was within a few miles of the launch complex, but some launches did result in deposition across Kennedy Space Center and/or Cape Canaveral Space Force Station. The Space Shuttle exhaust had 28,048 kilograms (61,835 pounds) of aluminum-based metals and 14,000 kilograms (30,864 pounds) of hydrogen chloride (NASA 2014).

Unlike the Space Shuttle, no heavy metals are present in the Starship/Super Heavy rocket propellant or plume. Metals could be ablated from the steel divertor and deluge plate and intermix with the Starship/Super Heavy plume and deluge water during launch. However, the potential 190 pounds of heavy metals (approximately 18% chromium, 74% iron, and 8% nickel) make up less than 0.3 percent of the heavy metals (aluminum compounds) seen during Space Shuttle launches. The Boca Chica Launch site is further from bodies of water than Launch Complex 39A and B at Kennedy Space Center,

reducing the potential for both near- and far-field impacts to aquatic species. Vegetative communities at Boca Chica are primarily wetland plants such as salt grass and shore grass, which would be expected to have similar impacts as those seen during the Space Shuttle program.

SpaceX sampled the deluge water used during the August 6 and August 25, 2023 static fire testing events at the Boca Chica launch pad (Table 1). Trace amounts of arsenic, barium, fluoride, and nitrate were present in the results and comparable to the quantities found in the potable source water. Higher levels of chromium, zinc, (components of stainless steel) aluminum, iron, and total suspended solids were seen in the initial tests. However, this was most likely due to remnants of stainless steel remaining in the deflector after being manufactured and residual rust in the water holding tanks and associated piping. Levels of chromium, aluminum, iron, zinc, and total suspended solids have since decreased dramatically with the second test showing below the numeric effluent limitations found in TCEQ's Industrial Stormwater multi-sector general permit. It is not expected the deluge water would contain any pollutants during future operations.

The amount of ablation from the Starship/Super Heavy plume on the steel would vary during each ignition event but is not expected to exceed 190 lbs. The metal components of the steel could remain localized to the launch pad, captured in the deluge water and retained onsite, or dispersed in vapor the plume.

Table 1. Analytical results from Water Deluge Sampling

Parameter	Potable Source Water	Sample Event 2 Static fire (off pad)	Sample Event 2 Static fire (retention pond)	Sample Event 4 Static fire (off pad)	Sample Event 4 Static fire (retention pond)	Sample Event 4 Static fire central outfall	
Date	8/18/2023	8/6/2023	8/6/2023	8/25/2023	8/25/2023	8/25/2023	Units
Arsenic, Total	0.00305	0.00156	0.00194	0.00583	ND	0.00657	mg/L
Barium, Total	0.169	0.0945	0.611	0.0922	0.122	0.113	mg/L
Cadmium, Total	ND	ND	ND	ND	0.00321	0.00237	mg/L
Chromium, Total	0.00122	ND	0.00675	0.00585	0.00697	0.0066	mg/L
Copper, Total	0.00602	0.00865	0.0233	0.00471	0.0155	0.00705	mg/L
Lead, Total	ND	ND	0.001	ND	ND	ND	mg/L
Mercury, Total	ND	0.363	0.224	ND	ND	ND	ug/L
Selenium, Total	ND	0.00226	ND	0.014	ND	0.0173	mg/L
DW Nitrate-Nitrogen Total	0.305	1.57	0.291	1.07	0.369	0.483	mg/L
DW Nitrite-Nitrogen, Total	ND	0.283	0.327	0.0634	0.0503	0.15	mg/L
Fluoride	0.643	1.34	0.72	0.805	0.61	0.525	mg/L
Cyanide, total	0.006	0.112	0.0414	0.0414	0.299	0.0336	mg/L
Laboratory pH	7.9	7.5	8.4	8.1	8.2	7.4	SU
Total Alkalinity (as CaCO3)	118	69.7	90	112	115	163	mg/L
Total Hardness (as CaCO3)	260	460	250	603	240	560	mg/L
Aluminum, Total	0.0614	0.415	0.833	0.218	0.951	0.952	mg/L
Calcium	68.8	152	66.8	149	69.5	143	mg/L
Copper, Total	0.00608	0.0085	0.0208	0.00506	0.0133	0.00839	mg/L
Iron, Total	0.0687	13.6	7.93	0.15	0.619	0.35	mg/L
Manganese, Total	0.00393	0.289	0.163	0.0179	0.0262	0.0223	mg/L
Sodium	136	618	143	792	135	517	mg/L
Zinc, Total	0.00721	0.0077	0.383	0.00695	0.18	0.0821	mg/L
Chloride	143	881	147	1070	152	4080	mg/L

Parameter	Potable Source Water	Sample Event 2 Static fire (off pad)	Sample Event 2 Static fire (retention pond)	Sample Event 4 Static fire (off pad)	Sample Event 4 Static fire (retention pond)	Sample Event 4 Static fire central outfall	
Date	8/18/2023	8/6/2023	8/6/2023	8/25/2023	8/25/2023	8/25/2023	Units
Fluoride	ND	1.38	ND	5.3	ND	ND	mg/L
Sulfate	232	337	230	402	232	630	mg/L
Total Dissolved Solids	700	1950	530	2450	660	7880	mg/L
Chemical Oxygen Demand	24.6	ND	ND	21.7	ND	33.2	mg/L
Phosphorus (as P), total	22.5	0.172	0.0694	0.277	0.176	0.0975	mg/L
Fluoride	ND	1.45	ND	ND	ND	ND	mg/L
Nitrate-Nitrite Nitrogen	ND	2.55	0.838	0.912	ND	ND	mg/L
Total Suspended Solids	ND	370	34	34.9	15.5	52.7	mg/L
Total Kjeldahl Nitrogen	1.28	0.959	0.588	1.29	1.3	1.94	mg/L
Biochemical Oxygen Demand	3.13	8.31	4.39	4.85	4.82	7.69	mg/L
Nitrogen, Total	1.28	3.509	1.426	2.202	1.3	1.94	mg/L

Source: SPL Inc 2023.

Forward Heat Shield Interstage

SpaceX proposes to add an interstage to Super Heavy consisting of a forward heat shield. The forward heat shield provides thermal protection against heat produced by Starship engines start during the stage separation event. It is made of stainless steel and is approximately 30 feet in diameter and 6 feet long, weighing approximately 20,000 pounds. For some missions, the forward heat shield would be jettisoned between 30 and 400 kilometers offshore in the Gulf of Mexico. SpaceX would not recover the forward heat shield as it is expected to sink.

Debris from the April 2023 launch

Since publication of the 2022 PEA, the April 20, 2023 launch resulted in debris from the damaged launch pad. The debris was largely confined within the 700-acre potential debris analysis area evaluated in the 2022 PEA; however, some debris (approximately 4%) extended to the south of this area in an area of approximately 20 acres (Figure 2). A majority of the debris outside of the 700-acre potential debris analysis area was located within 0.25 miles of the 2022 debris analysis area. The debris caused by the April 20, 2023 launch resulted from disintegration of the concrete launch pad, which is not expected to happen during future launch operations because SpaceX has reinforced its launch pad foundation with thicker concrete, additional piles, and steel plates. Given these changes to the launch pad, it is not reasonably foreseeable that debris from subsequent launches would extend beyond the 700-acre debris analysis area used in the PEA. Nonetheless, this WR evaluates whether this new information raises significant new circumstances or information relevant to environmental concerns and bearing on the proposed action or its impacts. The 700-acre potential debris analysis area from the 2022 PEA and the approximately 20 acres of debris outside of the original area are shown above in Figure 2.

SpaceX has adhered to its mitigation requirements by coordinating removal of the debris with TPWD, USFWS, and the FAA. SpaceX was directed by TPWD to pause work until the completion of bird breeding season (February 15 through August 31) in order to avoid potentially impacting nesting birds in the area. Starting on September 1, SpaceX began debris removal activities using methods approved by TPWD and in accordance with the 2021 Memorandum of Agreement (MOA) between SpaceX and TPWD (MOA 2021). SpaceX will continue to remove debris from the April 20 launch until the effects of the debris are ameliorated.

Newly Listed Species

Since the 2022 PEA and 2022 BCO, the cactus ferruginous pygmy-owl was included in the final listing rule published on August 21, 2023 (DOI 2023). The tricolored bat was also not considered in the May 2022 BCO. The tricolored bat was proposed for listing on September 14, 2022 (USFWS 2022b). These two species are evaluated in this WR.

Affected Environment

The Boca Chica Launch Site is located on SpaceX-owned land in Cameron County, Texas, near the cities of Brownsville and South Padre Island. The larger area around the Boca Chica Launch Site includes several private and public industries, including the SpaceX site known as Starbase, the Port of Brownsville, the City of Port Isabel, San Roman Wind Farm, and development on South Padre Island. Boca Chica Village now includes infrastructure, such as housing, restaurants, and offices to support SpaceX's production and manufacturing facility near Boca Chica Village. For all environmental impact categories, the affected environment remains the same as discussed in the 2022 PEA. Accordingly, the 2022 PEA remains valid documentation of the affected environment for the Proposed Action.

Re-evaluation of Environmental Consequences

This WR is intended to evaluate the potential environmental consequences associated with the proposed project changes and new information - operation of the deluge system, addition of the forward heat shield to the launch vehicle, and new information regarding debris from the April 2023 launch. The deluge system would be constructed within the boundary of the VLA and would not require an expansion of the VLA beyond the area previously considered in the 2022 PEA. The forward heat shield could be expended in the Gulf of Mexico. The analysis in this WR is focused on the environmental impact categories with the potential to be affected, including: cultural resources; Department of Transportation Act, Section 4(f) (DOT Act) resources; biological resources; hazardous materials, solid waste, and pollution prevention; water resources; and natural resources and energy supply.

Cultural Resources

The proposed action conforms to the proposed Starship/Super Heavy program evaluated in the 2022 PEA and FONSI/ROD; the data and analyses regarding cultural resources contained in the previous PEA and FONSI/ROD are still substantially valid; and pertinent conditions and requirements of the prior approval regarding cultural resources have been and will continue to be met in the current action.

The 2022 PEA determined that the project has the potential to affect 17 historic properties. Potential effects analyzed in the 2022 PEA could result from visual, auditory, or vibration effects. Other potential effects could result from increased visitation and use of the area due to SpaceX's presence, and, for two properties, potential effects from debris associated with an anomaly. The FAA made a finding of adverse effect for 17 historic properties. The FAA, State Historic Preservation Office (SHPO), National Park Service, Advisory Council on Historic Preservation, Texas Parks and Wildlife Department (TPWD), United States Fish and Wildlife Service (USFWS), and SpaceX executed a Section 106 Programmatic Agreement (PA) to resolve the adverse effects. The FAA determined with the resolution of adverse effects on historic properties, the Proposed Action would not result in significant impacts on historical, architectural, archeological, or cultural resources.

The 2022 PEA evaluated a 700-acre area of potential effects (APE) for anomaly debris based on the vehicle debris generated during anomalies associated with Starship/Super Heavy testing. In consultation with the SHPO and FAA, SpaceX updated its Unanticipated Discoveries Plan (UDP) for the Starship/Super Heavy undertaking. The UDP set forth the procedure for the treatment of any unexpected discoveries that may occur during the course of project activities, including test and launch operations. This plan also outlines a series of steps to mitigate unanticipated adverse effects to cultural resources from the proposed Federal action, including effects outside of the previously surveyed APE for Archaeological Resources.

In accordance with the UDP, following the April 2023 launch event, SpaceX's Cultural Resources Specialist (CRS) began assessing the debris field and debris impacts before they were directed to pause work until the completion of bird breeding season (February 15 through August 31) by TPWD in order to avoid potentially impacting nesting birds in the area. Debris retrieval activities have since resumed, starting on September 1, 2023, and the debris field has been documented and tested by the CRS per the SpaceX Unanticipated Discoveries Plan. During the assessment, the CRS evaluated the recorded cultural resources within the debris area (the Palmetto Pilings 1936 Centennial Marker [Historic Marker] and the Palmetto and Cypress Bridge Pilings [the Pilings]) and found no damage had occurred. SpaceX is currently in the process of removing debris.

Since the April 2023 launch event, SpaceX has made improvements to the launch pad to further mitigate the potential for damage and debris occurring during future launches. For future launches, pad debris is not expected to spread beyond the area previously analyzed in the 2022 PEA. The FAA submitted an Expanded APE (Figure 3) to the Texas Historical Commission on September 22, 2023 (Appendix C), and the Texas Historical Commission concurred with the APE on October 10, 2023 (Appendix C).

In October 2023, the CRS conducted a Phase I cultural resources investigation of an Expanded APE encompassing approximately 150 acres, located south of the launch pad (Figure 3). The goals of the investigation were to locate, record, and evaluate the potential significance for National Register of Historic Places eligibility of cultural resources within the Expanded APE.

During the Phase I survey, a pedestrian survey was combined with the excavation of 75 shovel test pits; 10 shovel test pits were extended with a hand-held ratchet-handled extensible auger. Of the excavated STPs and subsequent auger probes, none were positive for cultural material. Additionally, no historic resources are located within the Expanded APE. The FAA determined that the expansion

of the APE due to the April 20 flight had no effects to National Register of Historic Places -listed or -eligible cultural resources. In a letter dated October 26, 2023, the Texas Historical Commission concurred with the FAA's findings.

Figure 3 Aerial Overview of the Expanded APE

The 2022 PEA concluded that 16 of the National Register of Historic Places listed, eligible, or potentially eligible properties could potentially be adversely affected by vibrations caused by high sound levels. In accordance with the 2022 PEA and PA, SpaceX hired STRAAM Group (STRAAM), a qualified engineer with experience in vibro-acoustic measurements, to undertake a pre-launch condition assessment, take baseline vibration levels of these historic properties, and develop a monitoring plan for launch events. STRAAM determined that the following resources could potentially be damaged by vibrations caused by high sound levels: the Historic Marker, the Pilings, and the replica Fresnel Lens installed in the fall of 2022 at the Port Isabel Lighthouse. In coordination with the PA consulting parties, these structures were stabilized to mitigate effects due to vibrations. The Palmetto Pilings 1936 Centennial Marker did not have a sufficient foundation and was tilted. On October 16, 2022, SpaceX and THC reset the marker and added a more robust foundation, and the marker is no longer at risk of tipping due to elevated vibrations. STRAAM determined that the ten taller Pilings were at risk of damage due to elevated vibrations, and installed protective frames designed to mitigate vibration. These frames have been left in place at the direction of the consulting parties, and will be maintained by SpaceX. STRAAM also developed a simple wedge and strap system to implement at the replica Fresnel Lens in order to minimize independent movement of the lens during launch events. Additionally, STRAAM visually inspected each resource before and after the launch event.

In accordance with the 2022 PEA, the PA, and the SpaceX Boca Chica Vibration Monitoring Plan, STRAAM monitored the April launch event and all vibration minimizing measures described above were in place. STRAAM individually monitored the Palmetto Pilings 1936 Centennial Marker (Historic Marker), Palmetto and Cypress Bridge Pilings site (the Pilings), and the Port Isabel Lighthouse, including the replica Fresnel Lens. In addition, ground vibration monitors were placed 2, 3, 5 and 8 miles from the launch pad. The vibration monitoring determined that the majority of the energy transmitted by the launch was distributed through the air and not through the ground. Although the sensor on the Historic Marker appeared to only record background noise and may have malfunctioned, no damage was observed to the structure following the launch. STRAAM determined that the mitigation efforts implemented at the Pilings appeared to work, no damage was visible to the structures and elevated vibration thresholds were not triggered on the monitors. The overall dynamic signature of the Lighthouse and the Lens were both unchanged after the launch. The level of energy measured at the Lighthouse during launch was small and did not excite the Lighthouse to damaging levels. The response of the Lens during the launch was very similar to the response of the dome, indicating that the lens protection was successful in mitigating free motion of the lens, which may have been damaging. Finally, ground motion at the Lighthouse was minimal, and similar to the vibration intensity caused by normal truck traffic in the area. No damage to the Lighthouse was observed or recorded. The PEA and FONSI/ROD determined the Proposed Action may have adverse effects to historic properties, but determined adverse effects would be resolved through the PA. The vibration monitoring program demonstrates conformance to the Starship/Super Heavy program evaluated in the FONSI/ROD, that the findings in the PEA and FONSI/ROD regarding potential damage due to vibration remain substantially valid, and that the measures required in the PA have been undertaken regarding vibration.

SpaceX continues to mitigate impacts to cultural resources by implementing the mitigation measures established in the 2022 PEA and the 2022 PA. For example, the Historical Context Report has been reviewed in accordance with the PA during development and is scheduled to be completed by the end

of the 2023. SpaceX has worked with a qualified firm to develop the Scope of Work for the Level Historic American Landscapes Survey in coordination with the FAA, which was provided to the consulting parties for review and comment on October 27, 2023 in accordance with the PA.

Cumulative impacts to cultural resources may result from past, present, or reasonably foreseeable projects within the vicinity of the Boca Chica Launch Site. Ongoing economic development and continued activity, such as at the Port of Brownsville, could have an impact on cultural resources in the area. For example, development associated with the Rio Grande LNG project may have visual impacts to the Palmito Ranch Battlefield National Historic Landmark. The same may be said for other present or reasonably foreseeable future infrastructure or economic development projects, depending on the scope and vicinity of the projects to nearby cultural resources. The proposed installation of electrical and fiber optic utilities within the proposed 60-foot road width within Massey Way Road, Cameron County, Texas would have no effect to historic properties, including the nearby Palmito Ranch Battlefield (USFWS 2023). The Final Environmental Impact Statement for the planned Rio Grande Liquid Natural Gas facility in the Port of Brownsville notes that not all of the responsibilities under Section 106 of the NHPA have been completed and are still pending the completion of outstanding cultural resources surveys and subsequent review of the resulting reports and/or plans by FERC staff and THC (FERC 2019a). Developers have conducted viewshed and noise impacts assessments of two National Historic Landmarks, including the Palmito Ranch Battlefield and the Palo Alto Battlefield, and concluded that due to distance and topography, visual impacts would be moderate and minor, respectively. They also concluded that the Project would have no noise impacts on the National Historic Landmarks. Analysis of impacts due to installation of portions of the proposed pipelines is still outstanding due to access restrictions (FERC 2019a). The Texas LNG FEIS states that the process of compliance with Section 106 of the NHPA has not yet been completed for this project. One previously recorded archaeological site, Site 41CF8 (Garcia Pasture Site) would be adversely affected by the project, and FERC recommended that Texas LNG not begin construction until a MOA is executed to resolve adverse effects (FERC 2019b).

Construction within the APE for cultural resources could result in cumulative visual impacts on the cultural landscape of the Palmito Ranch Battlefield NHL and the Palo Alto Battlefield NHL. With implementation of mitigation measures outlined in the Programmatic Agreement, the 2022 PEA and through the MOA that will be prepared for the Texas LNG project, these potential cumulative impacts would be reduced. Therefore, implementation of the Proposed Action in conjunction with other past, present, or reasonably foreseeable projects would not result in significant cumulative impacts to cultural resources.

Accordingly, the data and analyses contained in the 2022 PEA remain substantially valid, and the proposed project changes would not result in significant cultural resources impacts.

Department of Transportation Act, Section 4(f)

Taking into account the proposed project changes and new information since issuance of the PEA and FONSI/ROD, the proposed action conforms to the Starship/Super Heavy program evaluated in the PEA and FONSI/ROD with respect to compliance with Section 4(f) of the DOT Act; the data and analyses in the PEA and FONSI/ROD regarding effects on Section 4(f) properties are still substantially

valid; and pertinent conditions and requirements of the prior analysis and approval have been, or will be, met in the current action.

The PEA and FONSI/ROD found that the potential for debris and debris-response activities would not result in a permanent incorporation or a more than *de minimis* temporary occupancy of Section 4(f) properties. Through the Section 4(f) consultation process in the 2022 PEA, the FAA determined that through the implementation of the terms of the 2021 MOA, debris and debris- response activities would not adversely affect the activities, features, or attributes that make Boca Chica State Park and Brazos Island State Park eligible for Section 4(f) protection, and any such impacts are expected to be *de minimis*, because debris and debris-response activities would be temporary and there would be no permanent effects to the property.

The debris field resulting from the April 2023 launch encompasses some of the same 4(f) resources previously analyzed in the 2022 PEA: Boca Chica State Park, Brazos Island State Park, Palmetto and Cypress Bridge Pilings, and Palmetto Pilings Historic Marker. Per the FONSI/ROD, SpaceX would continue to adhere to the 2021 MOA with TPWD to mitigate and restore any impacts from anomalies at Boca Chica State Park, Brazos Island State Park, and other TPWD land. SpaceX obtained a Special Use Permit from USFWS on April 20, 2023 following the test flight for debris removal activities. Per the FONSI/ROD, SpaceX would continue to obtain a Special Use Permit on an emergency basis from USFWS as applicable, for clean-up activities for any future anomaly debris on Refuge fee-owned or managed lands. Debris retrieval would not differ from what was previously evaluated and would not require additional anomaly response access restrictions beyond the 300 hours evaluated in the 2022 PEA. Following an anomaly, SpaceX would still inform local law enforcement when they can safely open State Highway 4 up to the “all hard checkpoint” located at Eichorn Blvd and State Highway 4. The area east of the “all hard checkpoint” would remain closed until SpaceX, in collaboration with Cameron County, determines the area is safe to open. SpaceX would coordinate with TPWD and USFWS to provide staff access to lands east of the hard check point as soon as, but only when, the area is safe to enter. SpaceX continues to adhere to the requirements of the 2022 PEA.

The FAA is ensuring SpaceX continues to mitigate impacts to Section 4(f) resources by means including but not limited to: issuing notifications in accordance with its Access Restriction Notification Plan, collaborating with USFWS to meet environmental education goals, collaboration with Fishing’s Future, implementing the SpaceX Lighting Management Plan, and undertaking research on restoration of algal flats with Texas A&M University.

As illustrated in the above Cultural Resources section, the proposed project changes and new information do not affect historic resources that qualify for protection under Section 4(f). Cumulative impacts to properties protected under Section 4(f) could result from past, present, or reasonably foreseeable projects within the vicinity of the Boca Chica Launch Site. Continued economic development and activity, both recreational and commercial, in the vicinity of the project area could have an impact on identified Section 4(f) properties. For example, public visitation to the Boca Chica Launch Site could increase visitation to the Palmito Ranch Battlefield, Boca Chica Beach, and Boca Chica State Park. As presented above, the FAA has made the determination that construction and operation associated with the Proposed Action would not result in the permanent incorporation, temporary occupancy beyond a *de minimis* impact, or a constructive use of a Section

4(f) property. The FAA also determined that the activities would not result in a substantial impairment of any Section 4(f) property, and any potential cumulative impacts on Section 4(f) properties would not be significant.

Accordingly, the data and analyses contained in the 2022 PEA remain substantially valid, and the proposed project changes would not result in significant DOT Act, Section 4(f) impacts.

Biological Resources

Taking into account the proposed project changes, the proposed action conforms to plans for which the prior 2022 PEA and FONSI/ROD have been issued, data and analyses regarding biological resources contained in the previous PEA and FONSI/ROD are still substantially valid, and pertinent conditions and requirements of the prior approval regarding biological resources have been, or will be, met in the current action. The 2022 PEA determined the Proposed Action would not be expected to result in significant impacts to biological resources.

In accordance with Section 7 of the Endangered Species Act (ESA), the FAA determined the Proposed Action may affect and is likely to adversely affect ESA-listed species and critical habitat under USFWS jurisdiction and conducted formal consultation with the USFWS. The USFWS issued a Biological Conference Opinion (BCO) in May 2022, which concluded the Proposed Action is not likely to jeopardize the continued existence of any federally listed species or adversely modify designated critical habitat. The BCO contains Reasonable and Prudent Measures and associated Terms and Conditions to avoid, minimize, and mitigate the effects on listed species and critical habitat. SpaceX must implement the Terms and Conditions. The FAA and SpaceX are committed to implementing the conservation measures and terms and conditions outlined in the BCO to minimize potential effects to ESA-listed species and critical habitat.

As described in the 2022 PEA, the FAA completed a programmatic ESA consultation with the National Marine Fisheries Service (NMFS) for launch and reentry operations in the marine environment (NMFS 2022). NMFS concurred with the FAA's determination that the space launch and reentry activities presented in the programmatic consultation would not adversely affect ESA-listed species or designated critical habitat and issued a programmatic Letter of Concurrence (LOC) (NMFS 2022). The same impact mechanisms and effects described and assessed as part of the NMFS consultation are applicable to non-protected species. The consultation concluded with NMFS concurring that SpaceX's landing and recovery operations would be unlikely to adversely affect federally listed threatened and endangered species.

Following the issuance of the 2022 NMFS LOC, the FAA initiated formal consultation with NMFS to evaluate additional information provided by SpaceX regarding Starship and Super Heavy planned descents during the first launch. Specifically, the consultation evaluated Starship's planned landing and Super Heavy's planned soft water landing, more clearly defined the existing launch profile for Starship and Super Heavy ocean landings, and evaluated the expansion of the potential area for Starship's ocean landing location. On April 14, 2023 NMFS provided a letter of concurrence for the FAA's determination of may affect, but is not likely to adversely affect ESA-listed species and designated habitat when considering this additional information (NMFS 2023a).

Marine Impacts

Due to the small size of the forward heat shield, no impacts to biological resources in the Gulf of Mexico are anticipated. The potential for striking any marine species upon landing in the ocean is very low. Direct strikes by debris are extremely unlikely due to the small size of the forward heat shield as compared to the vast open ocean. The forward heat shield is comprised of inert metal and its density is several times that of water; therefore, it is expected to sink. The inert material is not expected to corrode or release material. The 2022 PEA assumed that in the event that vehicles were expended downrange at sea, that most of the launch vehicle would sink because it is made of steel. Lighter items may float but would be expected to eventually become waterlogged and sink. In accordance with the PEA, if there are reports of large debris during future expended missions, SpaceX would coordinate with a party specialized in marine debris to survey the situation and sink or recover as necessary any large floating debris. SpaceX would continue to comply with its mitigation responsibilities as outlined in the NMFS LOC for launch and reentry vehicle operations in the marine environment (NMFS 2022).

Following the April 20 launch, consistent with the PEA, the large marine debris sank. No large debris remained floating or required removal. SpaceX provides a debris hotline and email address for the public to report any SpaceX debris.

Impact by Fallen Objects on Land

In the event of an anomaly, impacts would be similar to those described in the 2022 PEA. Although the April 20, 2023 test launch resulted in debris beyond the area evaluated in the 2022 PEA, the debris resulted from disintegration of the concrete launch pad, which is not reasonably foreseeable to happen during future launch operations because SpaceX has reinforced its launch pad foundation with thicker concrete, additional piles, and steel plates. No injured or killed animals were observed during the post-launch biological monitoring surveys (Raba Kistner 2023a).

In the event of a future anomaly, impacts to algal flats, which can occur on otherwise unvegetated mud flats, will be restored, in accordance with the FONSI/ROD and 2021 MOA. In coordination with TPWD, SpaceX has executed a contract with Texas A&M University to assist SpaceX with development and implementation of a restoration plan for damaged algal flats. The April 2023 test flight distributed debris onto areas of the mudflats containing algal flats. Any damage to algal flats will be restored as required in the 2021 MOA and the FONSI/ROD. Researchers from Texas A&M University are in the research stage of developing the restoration plan. Researchers have conducted site visits to the algal flats in the vicinity of the launch pad, collected Lidar imagery, and pigment analyses for samples have been completed. The goal of the research is to determine the most successful method for restoring debris impacts. SpaceX will implement this methodology to restore damage to algal flats from past and any future anomalies, and conduct monitoring to ensure restoration is successful.

Vegetation Changes

An influx of freshwater from deluge system operations could increase the amount of vegetation creep into the bare areas of the mud flats. When freshwater is added to vegetated areas, it can promote the growth of existing plants and encourage the expansion of their root systems. As plants grow and spread, they may extend their roots into adjacent areas, including the mud flats. However, some plants may not be adapted to the salinity, sediment composition, and availability of nutrients and struggle to establish in the mud flats. The amount of fresh water likely to leave the constructed part

of the VLA by overland sheet flow, push out, or condensation is comparable to slightly increased rainfall runoff, so the potential for significant vegetation changes is low. All water used in connection with the deluge system would comply with TCEQ water quality standards.

Vegetation monitoring near the VLA has tracked the composition and extent of three different habitat types that are present adjacent to the VLA: low-lying and unvegetated mud flats, a transition zone of halophytic vegetation, and short "hind dunes" (referred to in the monitoring reports as 'Bare', 'Transition', and 'Dune' communities). The monitoring also tracks encroachment ('creep') of vegetation at the transition between the unvegetated mud flats and halophytic salt flats. The vegetation monitoring report published in 2021 by University of Texas Rio Grande Valley (UTRGV) was previously evaluated in the May 2022 BCO and for the 2022 PEA. Since then, results from the 2022 vegetation monitoring effort were completed and used for the evaluation of this report. Between 2021 and 2022, plant cover within different habitat types was highly variable. There was a 57% decrease in total live plant cover in mudflats (from 1.87% to 0.80%) and a 20% decrease in transition plots (from 17.57% to 13.97%); however, live plant cover changed little in dune plots (from 26.2% to 26.4%), and there was a 20% increase in creep plots (from 15.7% to 18.8%). This was the lowest plant cover observed in mudflat and transition plots since 2018, and, for transition plots, this represents a continuing decline in plant cover. Creep plots also exhibited a gradual increase in plant cover. UTRGV identified two possible alternative explanations regarding the observed differences between plant communities in the different monitoring zones: It is possible that some of the observed differences could be explained by additional factors that have not been quantified or analyzed, such as proximity to the road or differences in elevation. Much of the variation observed over the past 7 years of monitoring has been within the range of natural variability, but some large changes attributable to land use change at the launch pad have also been observed (Appendix A, Attachment D). Primary constituent elements essential for conservation of piping plovers includes intertidal flats with sand and/or mud flats with no or very sparse emergent vegetation (USFWS 2001). The monitoring to date has not detected increased vegetation in the mudflat monitoring plots. Consistent with the PEA, SpaceX plans to eventually expand the VLA and develop the area south of the existing pad boundary.

In accordance with the SpaceX Biological Monitoring Plan, pre- and post-launch vegetation monitoring was conducted by Raba Kistner for the April 2023 launch. Raba Kistner evaluated a 0.6-mile radius area surrounding the VLA and found minimal damage to vegetation, consisting of sand and debris. Vegetation damage patterns were identified approximately 360 feet southwest and southeast of the VLA. Damage to the northern and western portions of the study area consisted of sand deposits and launch pad debris, with no other changes identified. The southeastern portion of the study area contained minor sand deposits and debris, with no loss of vegetation identified. The study areas surrounding the VLA and south of the VLA exhibited the most damage, consisting of heavy sand deposits, debris, and 3.5 acres of fire damage (Raba Kistner 2023b). No discoloration, browning or death of vegetation has been noted as a result of the deposited beach sand. It is expected that deposited sand will wash away from vegetation following rainfall, similar to sand deposited during normal wind events and no long-term impacts from the sand deposited on vegetation are expected. Additionally, the debris from the test flight will be removed in accordance with the 2021 MOA and the 2022 FONSI/ROD, and long-term changes to vegetation composition are not expected. The pre- and post-launch vegetation monitoring report was provided to USFWS and the FAA within two weeks of the launch event, in accordance with the SpaceX Biological Monitoring Plan.

Evaluation of the fire damaged area shows that the fire resulted in a temporary reduction of upland shrubs, in particular *Sophora tomentosa* (Hicks and Contreras 2023). Based on the vegetation recovery from past fires in the area documented to date, habitat function and ecosystem services should return to pre-burn levels within one to two growing seasons (Hicks and Contreras 2023). Changes to terrestrial habitat structure due to fires in small areas near the launch pad was evaluated in the 2022 PEA and 2021 BCO, and effects were found to be temporary and not significant.

Ablation is not expected to significantly impact vegetation. Near-field impacts to vegetative communities from the Space Shuttle exhaust varied by strata, but generally shrubs and small trees were eliminated by repeated defoliation more rapidly than forbs and graminoids. Near-field impacts to dunes occurred from some launches, but vegetation recovery was nearly complete within six months. Impacts to the dunes were found to be infrequent and cumulative changes in vegetation did not occur. NASA found far-field deposition to be sufficiently dispersed and variable launch-to-launch so successive launches seldom affected the same areas. No changes in plant community composition or structure due to cumulative effects of far-field deposition were seen**Error! Bookmark not defined.** (NASA 2015).

Truck Traffic

The initial filling of the water storage tanks will require deliveries by tanker trucks from either the nearby town of Brownsville or from Starbase. An average large-capacity tanker truck will hold approximately 5,000 gallons. Filling the water storage tanks to the 361,000-gallon capacity would require approximately 73 truck trips. If the entire capacity of the water storage tanks needs to be refilled after every activation of the deluge system (which is unlikely), then truck traffic would increase by approximately 2,190 trips per year. However, some of the water applied during deluge system operation would be captured by the containment structures and would be reused. It is not expected that the entire 361,000 gallons would need to be trucked in from other locations before each deluge system operation. Additionally, rainwater that falls on the launch pad area will be captured and collected the same way the deluge water is collected and used to further refill the water tanks. Various operations at Starbase produce clean process-water, which could also be reused. Water trucked in from Starbase would only need to travel approximately 3 miles to the water storage tanks at the VLA and the transportation would be limited to daylight hours to the greatest extent practicable. Only water meeting TCEQ water standards would be used. The 2022 BA stated it was anticipated that the combined construction activity and SpaceX staff vehicles would add up to approximately 505 vehicles per day along State Highway 4. Assuming the entire capacity of the water tanks is depleted between each ignition event and needs to be fully refilled, which is unlikely, the maximum additional traffic from water truck deliveries would add less than 1% to this estimated daily traffic load of trucks supporting the original Proposed Action in the 2022 PEA. The overall effects, including this increase, are not expected to have a significant effect to biological resources for the reasons discussed in the PEA. SpaceX continues to implement mitigation measures to reduce impacts to biological resources due to truck traffic, including but not limited to ensuring the shoulders of State Highway 4 remained mowed to increase visibility, providing a company shuttle for SpaceX employees and providing incentives for employee use, and limiting vehicle operations to existing paved and unpaved roads, parking areas, and authorized construction sites. No vehicle strikes of listed species have been reported to date.

ESA Listed Species

Since the 2022 PEA and 2022 BCO, the cactus ferruginous pygmy-owl was included in the final listing rule published on August 21, 2023 (DOI 2023). The pygmy-owl has a range that includes Cameron County, Texas (USFWS 2022a). Therefore, the pygmy-owl is considered in this WR in the Biological Assessment Addendum (Appendix A). The Species Status Assessment reports the current known distribution of the pygmy-owl as "Almost extirpated along Rio Grande, but more common now in areas of Kenedy and Brooks counties" (USFWS 2022a Table 4.2). Kenedy and Brooks Counties are approximately 42 miles from the action area. Preferred habitat for the pygmy-owl in Texas is associated with Southern Texas Plains ecoregions, which do not occur in the action area that is located in the Western Gulf Coastal Plains (Griffith et al., 2007). Cavity trees in thorny scrub and woodlands of live oak forests as well as large, columnar cacti are essential components of pygmy-owl habitat (USFWS 2022a), which are lacking in the action area. The action area ecoregion consists of vegetated flats of grass-stabilized dunes, wide tidal mud flats, vast seagrass meadows, and a hypersaline lagoon system (USFWS 2022a). Other birds that create cavities that may be used by pygmy-owls include woodpeckers and flickers. (USFWS 2022a). Daytime avian monitoring within 3 miles of the VLA has not documented pygmy-owls and has documented only a few auditory observations of the golden-fronted woodpecker in an area with yucca and mesquite 2.5 miles southwest of the action area (*personal communication*, Michael Heimbuch August 2023).

Cactus owls are poorly studied in Texas and the true distribution of the species is not known. The action area extends approximately 13 miles from the VLA, consistent with the spatial extent of overpressure events. USFWS reports that owls have been detected at the headquarters of the Laguna Atascosa National Wildlife Refuge. The headquarters are near the approximate boundary of the action area, suggesting that owls could be present and exposed to the effects of overpressure events (i.e., they could hear/feel sonic booms). Given this potential exposure, the appropriate effect determination is may affect but not likely to adversely affect the pygmy-owl.

The tricolored bat was also not considered in the May 2022 BCO. The tricolored bat was proposed for listing on September 14, 2022 (USFWS 2022b). The tricolored bat has a range that includes Cameron County, Texas (USFWS 2021). Therefore, the tricolored bat is considered in this WR in the Biological Assessment Addendum (Appendix A) . The known distribution of the tricolored bat includes Cameron County, Texas (Schmidly and Bradley 2016). According to the 2021 Special Status Assessment for the tricolored bat, the species roosts in woodland habitats with live or recently dead hardwoods, pines, and cedars during the spring, summer, and fall months (USFWS 2021). During the winter, tricolored bats hibernate in caves and mines, however in the South where caves are less common, they may also overwinter in culverts, tree cavities, and other abandoned artificial structures (USFWS 2021).

The action area encompasses a 0.6-mile radius zone surrounding the VLA in which the extent of impacts from the rocket heat plume and operation of the deluge system are estimated to reach. Within this radius, there is an absence of wooded habitat and a lack of structures, such as large culverts, that would provide optimal roosting or hibernation habitat. Tricolored bats may be present within this area while migrating from winter hibernacula to summer roosting habitat, however, it is unlikely that the species would utilize launch facility structures for roosting and hibernating as they

prefer landscapes with tree corridors and largely forested areas and are less abundant among urban development (USFWS 2021a) The area outside the 0.6-mile radius, but within the action area, is also prominently devoid of preferred habitat. Due to general lack of suitable habitat within the action area, the FAA-licensed SpaceX Starship/Super Heavy Launch Vehicle Program may affect, but is not likely to adversely affect, the tricolored bat.

In accordance with the FONSI/ROD, SpaceX conducted pre- and post-launch biological monitoring of vegetation and birds for the April launch. In accordance with the SpaceX Biological Monitoring Plan, qualified biologists surveyed for target species within a 1-mile radius of the launch pad for the bird surveys. Target species were ESA species and species identified by USFWS for additional monitoring-piping plover, snowy plover, Wilson's plover, red knots, and northern aplomado falcon. No injured or dead animals were detected through the surveys, and no take of listed species was reported (Raba Kistner 2023a). During the pre-launch surveys, 67 piping plovers, 13 snowy plovers, 65 Wilson's plovers, and zero red knots and northern aplomado falcons were observed. During the post-launch survey, some target species were more abundant and some species were less abundant. 22 piping plovers, 15 snowy plovers, 11 Wilson's plovers, 74 red knots, and zero northern aplomado falcons were observed. The variations in abundance in the pre- and post-launch bird monitoring is consistent with the natural, varied cycles of the target species that has been observed during the ongoing seasonal and construction monitoring conducted since 2015. The pre- and post-launch bird monitoring report was provided to USFWS and the FAA within two weeks of the launch event, in accordance with the SpaceX Biological Monitoring Plan.

Additionally, since the 2022 PEA and 2021 BCO, SpaceX has deployed avian biologists from SWCA Environmental Consultants (SWCA) with experience monitoring for coastal shorebirds to implement monthly surveys (starting in July 2022) as part of the SpaceX Biological Monitoring Plan. Trend analysis of the avian monitoring data collected by UTRGV from 2015 to 2021 found little to no evidence of meaningful trends, either increasing or decreasing, in the number of birds observed through time. SWCA's survey data from July 2022 to June 2023 are consistent with the natural, varied cycles of the target species. Additional years of data collection will likely allow for a more definitive conclusion regarding whether potential trends are more likely the result of background variation and sampling issues rather than trends in abundance. Only one aplomado falcon was observed several miles away from the VLA during the 2015-2023 period of surveys.

In accordance with the FONSI/ROD, SpaceX coordinated with Sea Turtle Inc. prior to the launch-related access restrictions of State Highway 4 and Boca Chica Beach to ensure any discovered eggs would be removed from the beach prior to launch. No sea turtle eggs were discovered during Sea Turtle Inc.'s surveys on April 19, 2023.

The FAA reinitiated formal consultation with USFWS in accordance with Section 7 of the ESA on October 5, 2023. The effect determinations for the ESA-listed species evaluated in the 2022 PEA are summarized in Table 2 and compared to the effect determinations for the new activities addressed in the Biological Assessment Addendum (Appendix A). USFWS provided confirmation of initiation of consultation on October 19, 2023.

On November 14, 2023 USFWS issued Reinitiation #1 of Interagency Consultation for the SpaceX Starship/Super Heavy Launch Vehicle Program at the SpaceX Boca Launch Site, Cameron County,

Texas (Reinitiation #1), concurring with the FAA's determinations regarding ESA-listed species and designated habitat when considering this additional information, summarized in Table 2 and below.

Please see the Reinitiation #1 of Interagency Consultation for the SpaceX Starship/Super Heavy Launch Vehicle Program at the SpaceX Boca Launch Site, Cameron County, Texas in Appendix B.

Table 2. Effect Determinations for ESA-listed and Proposed Species

ESA Listed Species	Original Effects Determination in BA	Effect Determination for Operation of Deluge System	Updated Overall Effect Determination
Eastern black rail	May affect, not likely to adversely affect	No effect	May affect, not likely to adversely affect
Northern aplomado falcon	May affect, likely to adversely affect	May affect, not likely to adversely affect	May affect, likely to adversely affect
Piping plover	May affect, likely to adversely affect	May affect, likely to adversely affect; No additional incidental take	May affect, likely to adversely affect
Piping plover critical habitat TX-01	May affect, likely to adversely affect	May affect, likely to adversely affect	May affect, likely to adversely affect
Red knot	May affect, likely to adversely affect	May affect, likely to adversely affect; No additional incidental take	May affect, likely to adversely affect
Proposed red knot critical habitat TX-11	May affect, likely to adversely affect	May affect, likely to adversely affect	May affect, likely to adversely affect
Cactus ferruginous pygmy-owl	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect
Gulf Coast jaguarundi	May affect, likely to adversely affect	May affect, likely to adversely affect; No additional incidental take	May affect, likely to adversely affect
Ocelot	May affect, likely to adversely affect	May affect, likely to adversely affect; No additional incidental take	May affect, likely to adversely affect
West Indian manatee	May affect, not likely to adversely affect	No effect	May affect, not likely to adversely affect
Green sea turtle	Adversely affect	No effect	Adversely affect

ESA Listed Species	Original Effects Determination in BA	Effect Determination for Operation of Deluge System	Updated Overall Effect Determination
Hawksbill sea turtle	Adversely affect	No effect	Adversely affect
Kemp's ridley sea turtle	Adversely affect	No effect	Adversely affect
Leatherback sea turtle	Adversely affect	No effect	Adversely affect
Loggerhead sea turtle	Adversely affect	No effect	Adversely affect
South Texas ambrosia	No effect	No effect	No effect
Texas ayenia	No effect	No effect	No effect
Tricolored bat	None	May affect, not likely to adversely affect	May affect, not likely to adversely affect

Note: National Marine Fisheries Service is proposing to designate new areas of critical habitat for threatened and endangered distinct population segments (DPSs) of the green sea turtle (NMFS 2023b). A small portion of the proposed area is on the edge of the action area. Impacts analyzed and the effect determinations on the Green sea turtle for the operation of the deluge system would remain unchanged should new critical habitat be designated within the action area.

As detailed in the BA addendum (Appendix A), operation of the deluge system and addition of a heat shield interstage conform to the analyses in the 2022 PEA and 2022 BA, with no new impacts identified. Operation of a deluge system was contemplated in these documents; however, sufficient data was not available at that time for adequate evaluation. This WR evaluates operation of the deluge system and demonstrates that operation of the deluge system conforms to plans for which the prior PEA and FONSI/ROD have been issued, data and analyses regarding impacts to biological resources are still substantially valid, and pertinent conditions and requirements of the prior approval have been, or will be, met in the current action. SpaceX also continues to conform to the requirements from the 2022 PEA, including the ongoing monitoring of protected birds and vegetation surrounding the launch pad on an ongoing basis and before and after launches. SpaceX continues to support Sea Turtle Inc. through supplying and storing field equipment, surveying for and transporting stranded sea turtles, and assisting with sea turtle nest surveys. SpaceX continues implementing measures to deter predators, including quarterly State Highway 4 and beach cleanups.

Based on the deluge water results, NASA's monitoring and analysis during and after the Space Shuttle program, and the chemical properties associated with SRB's and Starship's different propellants, the amount of metal in Starship/Super Heavy exhaust plume from the minimal amount of ablation on the stainless divertor would have no long-term negative effects to ecological communities and have no significant impact on biological resources. No federally listed threatened or endangered species were directly identified as being killed as a result of the Space Shuttle launch event, where ablation also occurred. Results of monitoring from the Space Shuttle launch impacts have shown no long-term macro-scale negative responses. Ecological communities persisted through the duration of the Space Shuttle program with no dramatic change in species composition or distribution (NASA 2015).

Accordingly, ablation associated with the Proposed Action is not expected to negatively impact biological resources in the project area. Additionally, SpaceX would sample the soil, water and air adjacent to the launch pad for components of stainless steel including but not limited to total chromium, iron, and nickel.

Cumulative impacts to biological resources may result from past, present, or reasonably foreseeable projects within the vicinity of the Boca Chica Launch Site. Compliance with the measures specified in ESA consultations and implementation of environmental protection measures would minimize impacts to special-status species. The proposed installation of electrical and fiber optic utilities within the proposed Massey Way Road was determined to not have effects to ESA species. The Refuge received concurrence for "May affect, not likely to adversely affect" for the ocelot, Gulf Coast jaguarundi, and northern aplomado falcon for the utility installation (USFWS 2023). There would be no adverse impacts to habitat and vegetation because the utilities would be installed entirely within the existing, previously disturbed Massey Way Road corridor (USFWS 2023). The Rio Grande LNG facility is anticipated to affect vegetated wildlife habitat, as well as open water onsite and in proposed dredging areas. In order to minimize impacts to migratory birds, Rio Grande LNG developed a Migratory Bird Conservation Plan that is to be finalized in consultation with TPWD and USFWS. The Federal Energy Regulatory Commission (FERC) also determined that the project is likely to adversely affect jaguarondi and ocelot based on direct and indirect habitat impacts. Section 7 consultation with USFWS and NMFS is ongoing for this project and will be completed prior to construction (FERC 2019a). Texas LNG has planned to minimize impacts to migratory birds by implementing measures in coordination with USFWS, including preconstruction bird surveys or vegetation clearing restrictions during construction and operation. FERC determined that the proposed project may affect, and is likely to adversely affect, the ocelot and aplomado falcon. USFWS indicated that the cumulative impact of the proposed Project when combined with other projects in the area, including the Rio Grande LNG Project and now discontinued Annova LNG Project, would result in significant cumulative impacts on the ocelot due to habitat loss. FERC also determined that the proposed project is not likely to jeopardize the continued existence of the eastern black rail, which was recently proposed to be listed as threatened. Consultation with USFWS and NMFS is ongoing for this project and will be completed prior to construction (FERC 2019b). Cumulative impacts to aplomado falcon, jaguarondi and ocelot are anticipated to occur; however, adherence to the mitigation and conservation measures developed in coordination with USFWS for the Proposed Action and LNG facilities would minimize these impacts. The proposed LNG Projects are anticipated to have the greatest cumulative impacts on ocelot habitat through removal and conversion to industrial uses and fragmentation, respectively. Cumulative impacts to vegetation are also anticipated to occur, however adherence to proposed mitigation measures and proposed restoration would minimize these impacts, which are not anticipated to be significant. Facility lighting plans for the Boca Chica Launch Site and the proposed LNG facilities will limit impacts to biological resources due to lighting. Therefore, implementation of the Proposed Action in conjunction with other past, present, or reasonably foreseeable projects would not result in significant cumulative impacts to biological resources.

During informal coordination following FAA's reinitiation request, SpaceX committed to implementing additional conservation measures as part of the Starship/Super Heavy launch program related to operation of the deluge and detonation suppression system. The following minimization and conservation measures will be incorporated in the project to minimize impacts to the ocelot, gulf

coast jaguarundi, piping plover, piping plover critical habitat, red knot and proposed red knot critical habitat. These measures were developed with input from USFWS and FAA.

1. SpaceX will use drone imagery to monitor the visible extent of water in overland sheet flow discharges and vapor plume from the developed VLA during deluge and detonation suppression system operation. SpaceX will summarize and report findings to FAA and the Service in each post-launch monitoring report and in the annual report.
2. SpaceX will schedule deliveries of water for the deluge and detonation suppression system to the VLA during daytime hours to the maximum extent practicable.
3. SpaceX will test water generated by its production and manufacturing facilities in Boca Chica to assure it is of comparable quality to potable water trucked in from Brownsville before adding it to the water tanks at the VLA. Findings will be reported to FAA and the Service in each post-launch monitoring report and in the annual report.
4. SpaceX will sample the soil, water, and air adjacent to the launch pad for components of stainless steel including but not limited to total chromium, hexavalent chromium, iron, and nickel according to the contaminants plan. Findings will be sent to FAA and the Service in each post-launch monitoring report and in the annual contaminants report.

USFWS included the following Terms and Conditions in Reinitiation #1:

"To be exempt from the prohibitions of section 9 of the ESA, the FAA and SpaceX must comply with the following terms and conditions that implement the reasonable and prudent measures described above and outlined in reporting/monitoring requirements. These terms and conditions are non-discretionary. The following terms and conditions implement reasonable and prudent measure 1:

1. FAA and SpaceX will coordinate with the Service in the design of a Contaminants Monitoring Plan, testing protocols and adaptive management strategies based on findings.
2. FAA will ensure that SpaceX will coordinate with the Service in the development, review, and concurrence of the final Contaminants Monitoring Plan to be completed within 3 months of the date of this letter.
3. FAA will ensure that SpaceX will include control sites to establish baseline conditions, with sampling collected prior to the next launch. Baseline data will be compared to future monitoring data to determine whether deposition and/or accumulation of potential contaminants is occurring. Sampling can occur in a phased approach, with more intensive sampling initially to ensure changes to the environment are captured, then potentially tapering off if contaminant levels remain low or otherwise do not indicate harmful impacts might occur. Sampling will occur after every launch beginning in 2023, twice a year after a launch in 2024, and potentially quarterly the following 3 years depending on the initial findings of the monitoring and whether contaminant accumulation is occurring.
4. FAA will ensure that SpaceX will test for changes in air, soil, water, and the benthic environment within the 0.6-mile water overland sheet flow and vapor plume impact areas. Sampling methods of air, water and benthic environment will be identified during the

development of the monitoring plan. The following Terms and Conditions are soil specific but could also be expanded to include other sample media during the development of the plan.

5. FAA will ensure that SpaceX must also collect soil samples outside the 0.6-mile water overland sheet flow and vapor plume impact areas for preliminary baseline monitoring (i.e., to establish background concentrations for comparison) prior to the next launch. Collecting soil samples from outside the 0.6-mile area will be more representative of natural conditions not impacted by past and ongoing launch activities.
6. FAA will ensure that SpaceX will, at a minimum, identify 3 representative transects extending radially from the VLA to 0.6-mile and collect 5 soil samples, equally spaced, from each of the transects. Depending on findings, the number of transects and number of samples may increase. Samples will be collected and stored in a manner appropriate for analysis.
7. FAA will ensure that SpaceX analyzes soil samples in a timely manner (i.e., not stored beyond what is necessary to transport to the lab), however, interpretation of the data may be deferred until the Contaminants Monitoring Plan is finalized. If monitoring indicates levels of contaminants are increasing, FAA will ensure that SpaceX will expand monitoring to include biological sampling sufficient to determine if levels are accumulating in wildlife. If contaminant levels are increasing in biota, FAA will ensure that SpaceX will conduct an Ecological Risk Assessment to determine if levels are approaching toxicity thresholds or are otherwise harmful to target species. If the Ecological Risk Assessment shows a contaminant risk to target species, the FAA will ensure that SpaceX will coordinate with the Service and other appropriate agencies to remove, reduce, and remediate contaminant levels in order to minimize or eliminate potential injury to listed species.

The following terms and conditions implement reasonable and prudent measure 2.

1. FAA and SpaceX will coordinate with the Service to update the 2022 BCO plans as necessary and review effectiveness of each plan as needed or at least annually.
2. FAA and SpaceX will coordinate with the Service to update the Biological Monitoring Plan to improve the quality of data being collected to track potential incidental take.

The following terms and conditions implement reasonable and prudent measure 3:

1. FAA and SpaceX shall comply with the reasonable and prudent measures described above and the required reporting and monitoring requirements below to ensure the amount of authorized incidental take is not exceeded and to further minimize the take.
2. Any failure by FAA and SpaceX to comply with these terms and conditions stated herein may result in loss of Section 9 take coverage. If noncompliance is expected, the Service is to be notified within 48 hours as to which term and condition cannot be implemented, including the reason for noncompliance, and FAA and SpaceX will begin coordination with the Service to identify potential remediation efforts."

Accordingly, the data and analyses contained in the 2022 PEA remain substantially valid, and the Proposed Action would not result in significant impacts on biological resources.

Hazardous Materials, Solid Waste, and Pollution Prevention

Taking into account the proposed project changes, the proposed action conforms to plans for which the prior 2022 PEA and FONSI/ROD have been issued, data and analyses regarding hazardous materials, solid waste, and pollution prevention contained in the previous PEA and FONSI/ROD are still substantially valid, and pertinent conditions and requirements of the prior approval regarding hazardous materials, solid waste, and pollution prevention have been, or will be, met in the current action. While not anticipated, SpaceX would respond to all accidental releases of polluting substances quickly and implement appropriate clean up measures in accordance with applicable laws to minimize impacts to the environment, as the associated mitigation measures in the 2022 PEA states.

As noted in the Biological Resources section, operation of the deluge system would not result in any additional hazardous materials or solid waste. In the event of a future anomaly, in accordance with the 2022 PEA, SpaceX would respond to all accidental releases of polluting substances quickly and implement appropriate clean-up measures in accordance with applicable laws to minimize impacts to the environment. In the event of a vehicle anomaly, hydraulic fluid from Starship and/or Super Heavy may remain contained in the vehicle, ignite, or be released. Remaining hazardous materials such as propellant, ordnance, or chemicals would be transported back to a processing facility in accordance with DOT regulations for transport of hazardous substances (Title 49 CFR 100-199). Per the FONSI/ROD, SpaceX would continue to store hazardous materials at the launch site in a manner consistent with applicable federal, state, and local environmental, public, and occupational health and safety regulations, which would prevent these materials from leaking, spilling, and potentially polluting soils, groundwater, and surface waters. The FAA would ensure SpaceX would continue to adhere to its Spill Prevention, Control, and Countermeasure (SPCC) Plan as required in the FONSI/ROD in order to minimize the potential for accidental releases of polluting substances from equipment or vehicles. SpaceX would continue to store hazardous materials on pallets under cover and with secondary containment and would not store incompatible materials together. SpaceX would provide sufficient space between stored containers to allow for spill clean-up and emergency response access. Storage units would meet building and fire code requirements and would be located away from vehicle traffic. SpaceX would continue to post storage instructions and train employees in proper receiving, handling, and storage procedures. SpaceX would continue to provide Safety Data Sheets for all materials stored on the site to all site personnel. Proper storage, handling, and cleanup of any hazardous materials spilled at the VLA would prevent contamination of water coming in contact with the VLA surface during deluge system operation.

The debris resulting from the April 2023 launch was non-hazardous, and largely consisted of concrete from the launch pad, which is inert. Due to the improvements detailed in this WR, disintegration of the concrete launch pad is not expected during future launches.

The metal components of the steel ablated during engine ignition events would remain localized to the launch pad, be captured in the deluge water and retained onsite, or dispersed through the plume and will not significantly impact or degrade water resources. Prior to and following a launch event, SpaceX would sample the soil, water and air adjacent to the launch pad for components of stainless steel including but not limited to total chromium, iron, and nickel to confirm pollutants are not released during operations.

Other projects have a potential for cumulative impacts to hazardous materials, pollution prevention, and solid waste in the vicinity of the Boca Chica Launch Site. Per the FONSI/ROD, management of hazardous materials and hazardous waste would continue to be conducted under all federal, state, and local laws and regulations for all projects. Best management practices would continue to be implemented to reduce the potential for impacts due to an inadvertent release of hazardous materials. When past, present, and reasonably foreseeable projects are analyzed in conjunction with the Proposed Action, significant cumulative impacts from these projects would not be expected.

Accordingly, the data and analyses contained in the 2022 PEA remain substantially valid, and the Proposed Action would not result in significant hazardous materials, solid waste, and pollution prevention impacts.

Water Resources

Taking into account the proposed project changes, the proposed action conforms to plans for which the prior 2022 PEA and FONSI/ROD have been issued, data and analyses regarding water resources contained in the previous PEA and FONSI/ROD are still substantially valid, and pertinent conditions and requirements of the prior approval regarding water resources have been, or will be, met in the current action.

The operation of the deluge system would apply a maximum of approximately 361,000 gallons per operation (static fire or launch) in combination with the detonation suppression system. Most of the water would be collected in the containment structures or vaporized; although the specific amount in either volume or relative percentage is unknown and may vary across ignition events. For the purposes of this analysis, SpaceX assumes that approximately 92% of the 358,000 gallons of water would be vaporized during engine and approximately 20% of the total water (approximately 71,000 gallons) would be dispersed outside the constructed portion of the VLA as overland sheet flow, push out, or condensation.

As required in the FONSI/ROD, SpaceX would continue to implement its SPCC Plan to minimize the potential for accidental releases of polluting substances from equipment and vehicles. SpaceX's adherence to the SPCC Plan would minimize or altogether avoid the potential for a contaminant to reach a surface water and impact water quality as a result of deluge system operations.

The retention ponds have been, and additional ones would be, constructed within the boundary of the VLA and would not require an expansion of the VLA beyond the area previously considered in the 2022 PEA. The retention ponds would be maintained and monitored by SpaceX. As described in the PEA, SpaceX would develop appropriate sampling protocols and water quality criteria in coordination with TCEQ[3] to confirm the water does not exceed the water quality criteria. SpaceX would pump water back to the water storage tanks at the VLA.

The vapor cloud would form as a result of the rocket engine fire vaporizing water from deluge system operation. The rocket engine fire includes exhaust from the combustion of the propellent fuels. As detailed in the PEA, the launch vehicles uses only liquid oxygen and cryogenic liquid methane. The

[3] Texas Administrative Code, Title 30 Environmental Quality, Part 1 Texas Commission on Environmental Quality, Chapter 307: Texas Surface Water Quality

exhaust produced from the combustion of liquid methane and liquid oxygen in the rocket engine primarily consists of carbon dioxide and water vapor; thus, the exhaust cloud would consist mainly of carbon dioxide and steam and would contain only trace amounts of other combustion byproducts such as carbon monoxide and nitrogen oxides. A more detailed discussion of the combustion products is found in the 2022 PEA Appendix G: Exhaust Plume Calculations for Space X Raptor Booster Engine, dated May 31, 2022, and is part of the existing FAA file. Due to the trace amounts, none of the combustion byproducts are expected to degrade the quality of water that may leave the VLA.

The 20% of the water that would be dispersed outside the constructed area would mainly be from the water that is released during the first 5 seconds prior to engine ignition and the water released after engine shutdown or launch. Once the engines ignite, the heat is expected to vaporize any water coming out of the deluge system. The deluge system impact area is an estimated 0.6-mile radius from the launch pad. This 0.6-mile radius is equal to about 723 acres. If 71,000 gallons were dispersed evenly across the entire 0.6-mile deluge system impact area, it would equate to 0.003 inches of water over this entire area. For the 0.3-mile radius zone with a 181-acre area, the amount of water dispersed evenly throughout would equate to 0.014 inches of water over this entire area. The estimated 20% of water not captured within a 300-foot zone surrounding the launch pad equates to 0.4 inches of water over the 6.5 acres.

The National Oceanic and Atmospheric Administration (NOAA) provides historical data on rainfall averages for various locations. According to their data, the average yearly precipitation from 2000-2022 in the nearby city of Brownsville, Texas, which is about 20 miles from Boca Chica Beach, is nearly 27 inches per year (US Dept of Commerce / NOAA / National Weather Service 2023).

Monthly Total Precipitation for Brownsville Area, TX (NOAA)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2000	0.85	0.19	2.89	0.39	1.87	0.85	0.28	4.29	0.66	2.71	0.41	1.10	16.49
2001	0.48	1.43	0.36	1.10	0.49	2.21	1.81	1.80	3.25	0.36	2.42	1.02	16.73
2002	0.09	0.98	0.22	0.64	1.96	1.88	0.84	1.87	6.04	8.31	4.22	1.24	28.29
2003	0.69	0.55	0.56	0.41	0.19	3.24	2.58	2.74	15.13	6.90	0.44	0.31	33.74
2004	1.84	0.79	3.63	2.85	5.37	3.19	0.38	2.35	4.05	1.98	1.82	1.46	29.71
2005	0.57	0.78	0.24	0.03	1.17	0.06	3.32	0.77	2.70	1.43	1.84	1.50	14.41
2006	0.68	0.14	0.42	0.05	3.46	0.24	1.90	2.89	3.67	5.02	1.16	2.04	21.67
2007	1.84	0.90	5.50	0.56	1.91	5.23	4.73	3.16	5.32	1.02	0.77	0.11	31.05
2008	1.34	0.04	0.28	3.35	0.61	0.62	13.24	2.61	9.57	3.26	2.98	0.47	38.37
2009	0.11	0.47	0.11	T	4.52	0.49	0.24	0.60	9.43	3.12	1.46	5.64	26.19
2010	0.61	4.08	0.90	1.53	2.99	7.62	5.14	0.92	12.63	0.00	0.13	0.01	36.56
2011	2.42	0.06	0.07	0.00	0.08	8.88	0.71	0.22	2.14	1.25	0.55	1.55	17.93
2012	0.34	4.24	0.51	0.26	1.14	3.85	2.17	3.85	3.76	0.80	0.16	0.32	21.40
2013	1.47	0.01	0.28	3.10	0.74	0.85	2.13	1.47	11.88	1.63	1.93	3.52	29.01
2014	0.68	0.07	1.46	0.28	2.83	0.64	1.64	1.91	10.36	3.82	3.46	1.43	28.58
2015	3.56	0.76	4.74	1.73	9.72	0.76	2.36	3.03	3.84	13.68	2.54	0.16	46.88
2016	1.88	T	2.67	3.26	2.18	2.98	0.18	0.51	1.98	1.08	4.42	1.67	22.81
2017	0.18	1.36	1.84	0.63	1.85	3.49	2.31	1.38	4.64	3.25	0.79	1.15	22.87
2018	0.76	1.47	0.49	1.90	0.68	5.21	0.48	0.48	7.71	1.31	1.90	0.65	23.04
2019	1.60	0.30	2.22	0.41	1.15	4.38	2.56	1.07	4.58	3.38	0.45	0.74	22.84
2020	0.53	0.10	0.07	0.39	2.38	5.66	4.93	0.46	5.96	0.06	0.45	1.34	22.33
2021	0.90	0.61	0.90	1.55	4.96	1.67	9.54	0.50	4.64	9.17	3.84	1.32	39.60
2022	2.54	1.88	0.12	3.03	5.14	0.13	0.25	2.87	4.56	2.30	5.44	0.25	28.51
Mean	1.13	0.92	1.33	1.19	2.50	2.79	2.77	1.82	6.02	3.30	1.89	1.26	26.91
Max	3.56 2015	4.24 2012	5.50 2007	3.35 2008	9.72 2015	8.88 2011	13.24 2008	4.29 2000	15.13 2003	13.68 2015	5.44 2022	5.64 2009	46.88 2015
Min	0.09 2002	T 2016	0.07 2020	0.00 2011	0.08 2011	0.06 2005	0.18 2016	0.22 2011	0.66 2000	0.00 2010	0.13 2010	0.01 2010	14.41 2005

Source: US Dept of Commerce / NOAA / National Weather Service 2023

Per the table above, an average summertime thunderstorm at Boca Chica would deposit more water over the landscape than any single or all combined activations of the deluge system. Since the amount of water that is anticipated to reach the mud flats from a maximum operation of the deluge system is expected to be less than an average summer rainfall event, this amount of water would be unlikely to alter water quality.

The metal components of the steel ablated during engine ignition events would remain localized to the launch pad, be captured in the deluge water and retained onsite, or dispersed through the plume and will not significantly impact or degrade water resources. Prior to and following a launch event, SpaceX would sample the soil, water and air adjacent to the launch pad for components of stainless steel including but not limited to total chromium, iron, and nickel to confirm pollutants are not released during operations.

Cumulative impacts on water resources from past, present, and future actions near the Boca Chica Launch Site would be less than significant because of Best Management Practices (BMPs) to control stormwater runoff, erosion, and sedimentation would be used throughout all phases of construction for each project. Adherence to permit conditions would reduce impacts and mitigation would compensate wetland losses. Therefore, implementation of the Proposed Action in conjunction with other past, present, or reasonably foreseeable projects would not result in significant cumulative impacts to water resources.

Accordingly, the data and analyses contained in the 2022 PEA remain substantially valid, and the Proposed Action would not result in significant impacts on water resources.

Natural Resources and Energy Supply

Taking into account the proposed project changes, the proposed action conforms to plans for which the prior 2022 PEA and FONSI/ROD have been issued, data and analyses regarding natural resources and energy supply contained in the previous PEA and FONSI/ROD are still substantially valid, and pertinent conditions and requirements of the prior approval regarding natural resources and energy supply have been, or will be, met in the current action. The initial filling of the water storage tanks would require deliveries by tanker trucks from either the nearby town of Brownsville or from Starbase. Additionally, rainwater that falls on the launch pad area would be captured and collected the same way the deluge water is collected and used to further refill the water tanks. Various operations at Starbase produce clean process-water, which could also be reused in the deluge system. The operation of the deluge system would use a maximum of approximately 361,000 gallons of water per operation (static fire or launch) at the orbital launch pad and would operate up to 30 times per year.

As noted in the 2022 PEA, the nearest municipal water supply is the City of Brownsville. Based on the Texas Water Development Board projected municipal water use in Brownsville from 2020 through 2070, the projected municipal water usage in 2020 was 31.7 million gallons per day (MGD), and projected municipal water use in 2030 is 36.8 MGD (TWDB 2021). In the unlikely event that the deluge system had to be refilled after each system use, the 30 operations would require 10,830,000 gallons annually. This represents a negligible amount of the water projected for use in Brownsville by 2030 and is not expected to result in significant impacts on natural resources. According to the U.S. Drought Monitor, Brownsville is not experiencing a drought (U.S. Drought Monitor 2023). The 2022 PEA evaluated the use of up to 350,000 gallons of deluge water per static fire or launch event and also determined there would not be significant impacts on natural resources.

Cumulative impacts to natural resources and energy supplies could occur due to projects near the Boca Chica project area consuming energy and natural resources. There are other ongoing and future construction projects, both private and public, near the Boca Chica area that will result in cumulative consumption of resources. However, the Proposed Action is not expected to contribute in any substantive manner to adverse cumulative impacts to supplies of natural resources or energy use. There are resource providers located throughout the state of Texas and beyond to provide resources and supplies to projects in the area. Under the Proposed Action, there would be increases in the consumption of fuel, oil, propellants, electricity, aggregate water, and groundwater. Recent studies indicate that local, regional, and nationwide suppliers would be able to accommodate the increases in consumption of these resources, resulting in no significant impacts. Additionally, the municipal supply would also be able to accommodate the increased consumption with no significant impacts. When past, present, and reasonably foreseeable projects are analyzed in conjunction with the Proposed Action, there would be a cumulative increase in the demand on natural resources and energy supply within the surrounding communities. The cumulative impacts are not anticipated to be significant.

Accordingly, the data and analyses contained in the 2022 PEA remain substantially valid, and the Proposed Action would not result in significant impacts on natural resources.

Air Quality and Soils

As described above, the amount of ablation from the Starship/Super Heavy plume on the steel would vary during each engine ignition event but is not expected to exceed 190 pounds. The metal components of the steel could remain localized to the launchpad, captured in the deluge water and retained onsite, or dispersed in vapor in the plume. Unlike NASA's Space Shuttle, no heavy metals are present in the Starship/Super Heavy rocket propellant or plume. Based on SpaceX's deluge water sampling results, NASA's monitoring and analysis during and after the Space Shuttle program, and Starships' different propellants, the amount of metal in Starship/Super Heavy exhaust plume from the minimal amount of ablation on the stainless-steel diverter would have no long-term negative effects to ecological communities and have no significant effects on air quality.

Ablation of steel would not result in significant impacts to soils. Post-launch soil analysis from the Space Shuttle exhaust found aluminum, copper, iron, lead, manganese, and zinc. Zinc concentrations above background levels were due to the large amounts of corrosion control materials on the launch pads and mobile service platform services, as SRB exhaust blasts were known to strip the coating off these exposed surfaces (NASA 2015). This type of stripping is not present for Starship/Super Heavy launches.

Following testing events, SpaceX has not observed physical signs of ablation of steel structures at the VLA. Additionally, prior to and following a launch event, SpaceX would sample air and soils adjacent to the launch pad for components of stainless steel including but not limited to total chromium, iron, and nickel.

Cumulative impacts on air quality from past, present, and future actions near the Boca Chica Launch Site would be less than significant. The Boca Chica Launch Site is located in Cameron County which is in an attainment area (Environmental Protection Agency 2023). The operational emissions for the Proposed Action represent an extremely small percentage of the Cameron County regional emissions and would not cause an exceedance of any NAAQS. The Proposed Action would result in temporary air emissions during a launch operation. It should be noted that each launch, landing, or static test fire operation would occur separately, avoiding simultaneously combining impacts associated with exhaust plumes from more than one operation at a time. Air emissions from other projects would be localized and short-term in nature. Air emissions from the Proposed Action when combined with other past, present, or reasonably foreseeable future actions would not result in an exceedance of any NAAQS and therefore would not result in significant cumulative air quality impacts. Significant cumulative impacts to soils are also not expected, because projects in the area would also be required to adhere to local, state, and federal requirements to prevent pollutants from being released to soils. Therefore, implementation of the Proposed Action in conjunction with other past, present, or reasonably foreseeable projects would not result in significant cumulative impacts to air quality or soils.

Accordingly, the data and analyses contained in the 2022 PEA remain substantially valid, and the Proposed Action would not result in significant impacts to air quality.

Conclusion

The 2022 PEA examined the potential for significant environmental impacts from Starship/Super Heavy launch operations at the Boca Chica Launch Site and defined the regulatory setting for impacts associated with Starship/Super Heavy. The areas evaluated for environmental impacts in this WR included cultural resources; Department of Transportation, Section 4(f); biological resources; hazardous materials, solid waste, and pollution prevention; water resources; natural resources and energy supply, air quality and soils.

The FAA will further ensure that the additional information assessed in this WR does not invalidate the contents of the 2022 PEA by adding these new conditions to the modification of the vehicle operator license:

1. SpaceX will use drone imagery to monitor the visible extent of water in overland sheet flow discharges and vapor plume from the developed VLA during deluge and detonation system operation. SpaceX will summarize and report findings to FAA and the USFWS in each post-launch monitoring report and in the annual report.
2. SpaceX will schedule deliveries of water for the deluge and detonation suppression system to the VLA during daytime hours to the maximum extent practicable.
3. SpaceX will test water generated by its production and manufacturing facilities in Boca Chica to assure it is of comparable quality to potable water trucked in from Brownsville before adding it to the water tanks at the VLA. Findings will be reported to FAA and the USFWS in each post-launch monitoring report and in the annual report.
4. SpaceX will sample the soil, water, and air adjacent to the launch pad for components of stainless steel including but not limited to total chromium, hexavalent chromium, iron, and nickel according to the contaminants plan noted below. Findings will be sent to FAA and the USFWS in each post-launch monitoring report and in the annual contaminants report.
5. FAA and SpaceX will coordinate with the USFWS in the design of a Contaminants Monitoring Plan, testing protocols and adaptive management strategies based on findings noted above.
6. FAA and SpaceX will coordinate with the USFWS in the development, review and concurrence of the final Contaminants Monitoring Plan to be completed within 3 months of the date of Reinitiation #1.
7. SpaceX will include control sites to establish baseline conditions, with sampling collected prior to the next launch. Baseline data will be compared to future monitoring data to determine whether deposition and/or accumulation of potential contaminants is occurring. Sampling can be a phased approach, with more intensive sampling initially to ensure changes to the environment are captured, then potentially tapering off if contaminant levels remain low or otherwise do not indicate harmful impacts might occur. Sampling will occur after every launch for the first year, twice a year after a launch for the second year, and potentially quarterly the following year depending on the initial findings of the monitoring and whether contaminant accumulation is occurring.

8. SpaceX will test for changes in air, soil, water, and the benthic environment within the 0.6-mile water overland sheet flow and vapor plume impact areas. Sampling methods of air, water and benthic environment will be identified during the development of the monitoring plan. The following three terms and conditions are soil specific but could also be expanded to include other sample media during the development of the plan.
9. SpaceX must also collect soil samples outside the 0.6-mile water overland sheet flow and vapor plume impact areas for preliminary baseline monitoring (i.e., to establish background concentrations for comparison) prior to the next launch. Collecting soil samples from outside the 0.6-mile area will be more representative of natural conditions not impacted by past and ongoing launch activities.
10. SpaceX will, at a minimum, identify 3 representative transects extending radially from the VLA to a distance of 0.6-mile and collect 5 soil samples, equally spaced, from each of the transects. Depending on findings, the number of transects and number of samples may increase. Samples will be collected and stored in a manner appropriate for analysis.
11. SpaceX will analyze soil samples in a timely manner (i.e., not stored beyond what is necessary to transport to the lab), however, interpretation of the data may be deferred until the Contaminants Monitoring Plan is finalized. If monitoring indicates levels of contaminants are increasing, FAA will ensure that SpaceX will expand monitoring to include biological sampling sufficient to determine if levels are accumulating in wildlife. If contaminant levels are increasing in biota, FAA will ensure that SpaceX will conduct an Ecological Risk Assessment to determine if levels are approaching toxicity thresholds or are otherwise harmful to target species. If the Ecological Risk Assessment shows a contaminant risk to target species, the FAA will ensure that SpaceX will coordinate with the Service and other appropriate agencies to remove, reduce, and remediate contaminant levels in order to minimize or eliminate potential injury to listed species.
12. SpaceX will coordinate with the USFWS to update the 2022 BCO plans as necessary and review effectiveness of each plan as needed or at least annually.
13. SpaceX will coordinate with the USFWS to update the Biological Monitoring Plan to improve the quality of data being collected to track potential incidental take.
14. SpaceX shall comply with the reasonable and prudent measures and the required reporting and monitoring requirements described in Reinitiation #1 to ensure the amount of authorized incidental take is not exceeded and to further minimize the take.

Based on the above review and in conformity with FAA Order 1050.1F, Paragraph 9-2.c, the FAA has concluded that the modification of an existing vehicle operator license for Starship/Super Heavy operations conforms to the prior environmental documentation, that the data contained in the 2022 PEA remains substantially valid, that there are no significant environmental changes, and all pertinent conditions and requirements of the prior approval have been met or will be met in the current action. Therefore, the preparation of a supplemental or new environmental document is not necessary to support the Proposed Action.

STACEY MOLINICH ZEE

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Date: 2023.11.15 11:32:58 -05'00'

Responsible FAA Official: _____

Location and Date Issued: _____

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Appendix A. 2023 Biological Assessment Addendum

Appendix B. 2023 Biological Conference Opinion

Appendix C. Cultural Resources Documentation